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KEY

TO THE RICHMOND FOSSILS.

BY D. W. DENNIS.

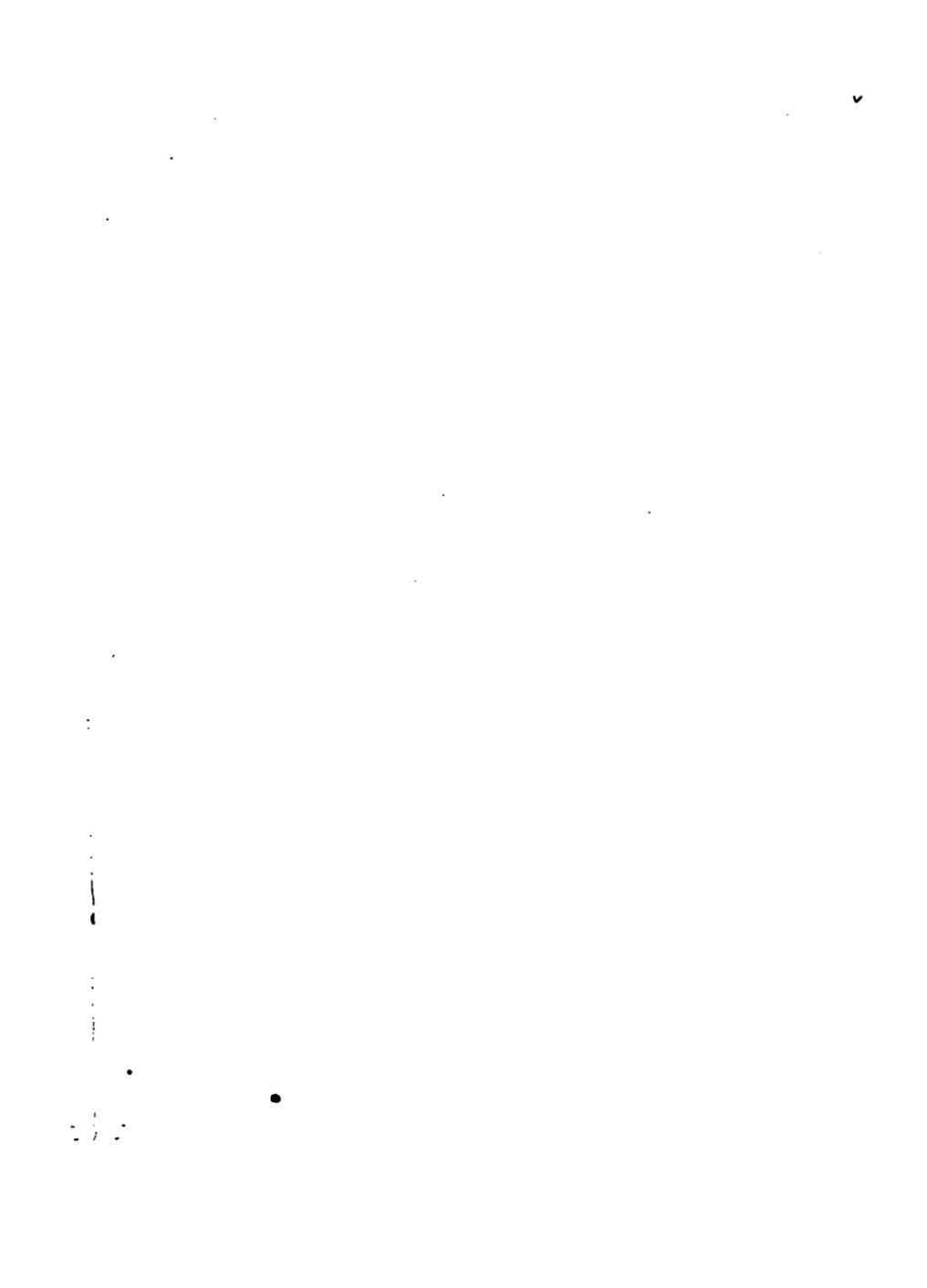
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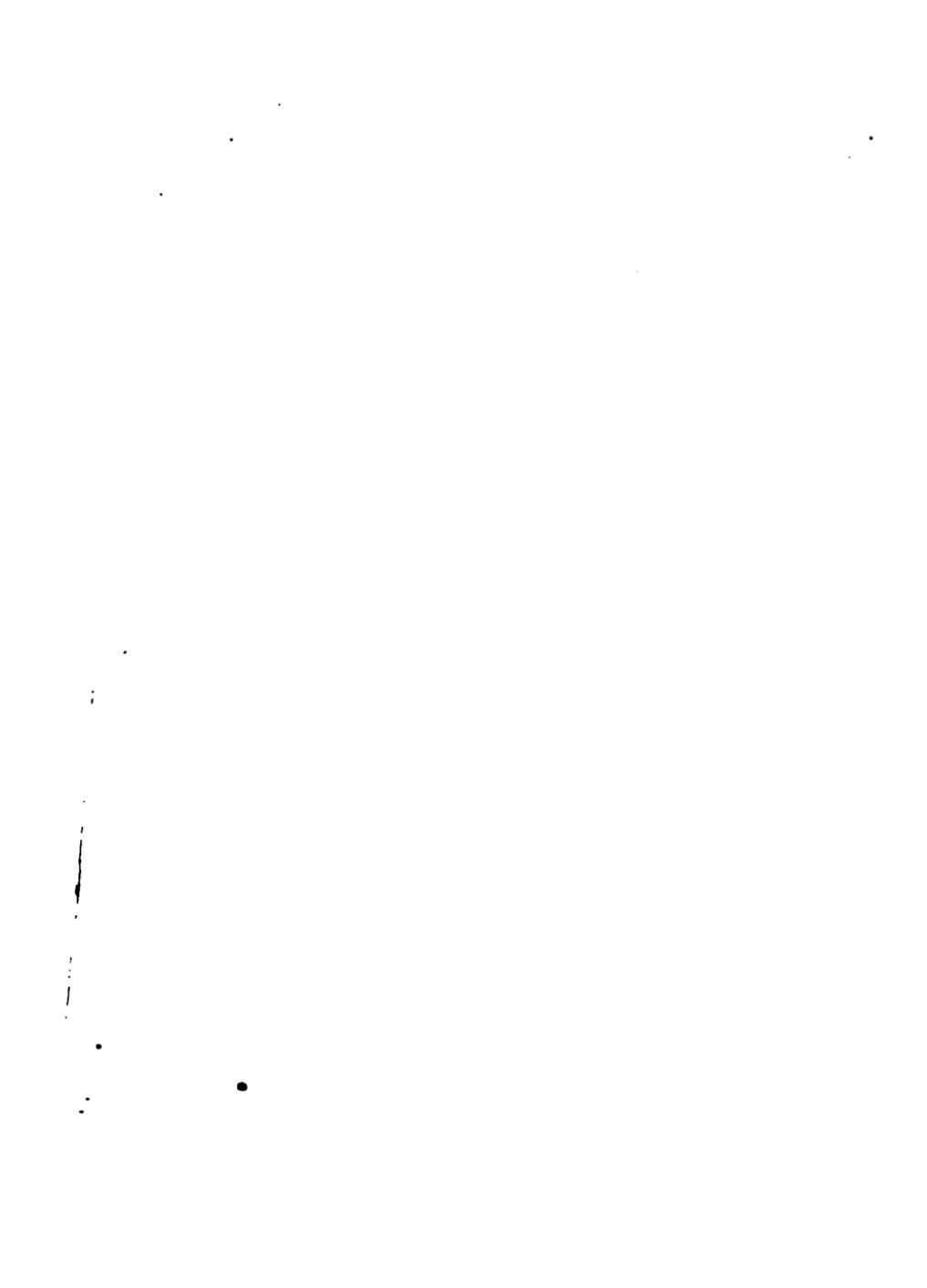


Fig. 1. *MONTICULIPORA INDIANAENSIS* Page 16.

The under side (epitheca) of a medium-sized specimen, 5 inches in diameter, growing on a valve of an *Ambonychia*; the shell is nearly all broken away.

AULOPORA ARACHNOIDÆ, (Page 18), and *CERAMOPORA OHIOENSIS*, (Page 25), are also shown parasitic on the epitheca.

Fig. 2.—Upper view of same, magnified four diameters.

Fig. 3.—*CONULARIA DOANI* Page 35.
Fragment figured, 3½ inches long.





بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

- Fig. 4.—*PTILODICTYA MONTICULIFERA*.....Page 25.
Magnified four diameters.
- Fig. 5.—Same. The mode of growth, from a small, compact, horn-like beginning, is shown. I found this specimen after the description was in press.
- Fig. 6.—*RAPHISTOMA PLANISPIRA*.....Page 41.
The side shown is a plane surface.

6at

J. C. Hammer

AN

ANALYTICAL KEY

TO THE

FOSSILS OF THE VICINITY

— OF —

RICHMOND, IND.

By D. W. DENNIS,

Teacher of Natural Science in the City High School.

THE UNIVERSE IS NOT DEAD AND DEMONIACAL, A CHARNEL HOUSE
WITH SPECTRES, BUT GOD-LIKE AND MY FATHER'S.—*Carlyle*.

RICHMOND, IND.

RICHMOND, IND.:
DAILY PALLADIUM PRINTING HOUSE,
1878.

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“He prayeth best who loveth best
All things both great and small;
For the dear God who loveth us,
He made and loveth all.”

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P R E F A C E .

The following pages have been prepared for the student. Such terms, and only such, have been introduced as are necessary to furnish a natural basis for classification, and these are all defined as here used.

The scientific names have been used because the specimens have no other names; the definitions are, however, appended, and it is to be sincerely hoped that no one will be deterred from the study of our fossils by these. It has been very truly, if not scientifically, said:

The shell with lines of beauty marked you'll find on every hill,
Is christened streptorhynchus for the twist upon its bill;
And though you cannot find the twist, the shell is pretty still.

The great good derived from the study of our fossils lies in what we may learn of the events of the long ages during which the pleasant site of our city has been under the preparing hand of the Creator.

But nature pleases while she instructs; there lies many a cabinet ornament within half an hour's walk of our homes, and there is much pleasure in the task of gathering them and learning their story.

The work of preparing this pamphlet has been its own reward. It was suggested by the needs of the classroom. If it shall make the way more easy for the student, I shall be over-paid.

To all my friends who have loaned me specimens for examination, I desire to return my thanks.

I am under obligations to President Moore for the use

of the Earlham College Cabinet, from which I obtained valuable assistance; to S. A. Miller, of Cincinnati, for the assistance derived from his excellent Dictionary of the Palæozoic Fossils; to Mr. Nordyke for the use of his star-fish, and especially to Mrs. M. P. Haines, who has kindly given me the constant use of her beautiful and complete private collection. The use of her classified and labeled specimens has enabled me to do in a few months what would otherwise have required years.

RICHMOND, June, 1878.

D. W. D.

N O T E .

The student will bear in mind that these tables have been prepared for our home fossils only, and that they may or may not serve as a guide to the same genera as represented by other species in other localities.

The specific distinctions have been made out on the same plan. Those features and only those have been given, which are necessary to distinguish a given species from others found here. The student is referred, however, under each description, to a work in which a full description and a cut are given. This makes the Key a dictionary of reference also.

The descriptions here given are true descriptions of the fossils found; they have all been made from nature. There is sometimes doubt about the names, and especially of the casts of Lamellibranchs. Another trouble arises from the multiplicity of synonyms. One of our shells, the *Strophomena rhomboidalis*, has been described since 1769, and it has been called since that time by *thirteen* different names, and still its freshness and beauty are unimpaired.

I have given the names as given in Miller's Dictionary, and as the Ohio Reports are so extensively circulated, I have given the synonyms which occur in that work. The present work is as complete as our present knowledge will permit. It has been truly said that a work on Geology is out of date as soon as published. This has been verified here, within the last few months at least, for hardly a week

has passed without the discovery of one or more new species; and, again, there are at least a dozen species here with which I am acquainted, and concerning which there are conflicting opinions. To decide where they belong will require much time and labor. As soon as a sufficient number of new species are determined to justify it, a supplementary sheet will be issued.

REMARKS ON STRATA, Etc.

Our rocks chiefly belong to the upper part of the Cincinnati epoch, which is itself the upper epoch of the Lower Silurian; but the Niagara period of the Upper Silurian is also represented at various places in the vicinity. At Elkhorn Falls the succession of epochs may easily be noted. The stones quarried at that place belong to the Cincinnati epoch. This is shown by the presence in them of many of our commonest fossils. Just above these is a stratum of blue clay, and above this the "cliff rocks" of that neighborhood, which belong to the Niagara *period* of the Upper Silurian. These rocks may be known by their general aspect, or by the coral, *Favosites gothlandicus*. To this stratum of blue clay Elkhorn Falls owes its existence. Being much softer than the Niagara rocks above, it easily washes out, and the projecting shelf rock furnishes the support for the falls; replace the blue clay by cliff rocks and we should have rapids. The rocks at Middleboro are also Upper Silurian. The same is true of the rocks at Eaton, Ohio, and at a point just north of the New Paris pike in the neighborhood of Hill's mills. The nearest approach of this formation is the one on the Earlham farm, on the east side of the west grove, where many pieces of chain coral and other characteristic specimens have been found; but as this is surrounded by Lower Silurian rocks on all sides, at distances varying from a few hundred feet to less than a half mile, I judge

that it, large as it is, was brought there during the drift period.

The subject of the old river bed—which bed extends along where the stratified rocks are missing in front of the residence of Mr. Deal, near the toll house west of the National bridge, and which can be traced in a dry season through the fields both north and south by the grain of a fresher green—interesting as it is—can only receive this notice here.

The conditions of the sea in this vicinity during the time the layers were being spread out must not go entirely unnoticed. *Leptena* and *Strophomena* flags may be found near Mering's mill, at the lowest horizon exposed at that place, in which the shells are evenly distributed and nearly all are lying the same side up. I have never seen a flag from that horizon and locality in which any of the shells stand on edge; but at many other localities and horizons it is not at all uncommon to find these same shells standing at all possible angles in the layers, and bearing in other respects the marks of a turbulent sea. Moreover, the rule in the locality and horizon spoken of is that the two pieces of bivalvular shells are united, while at Test's mills the rule is that they are separated. From these and other things it is clear that the lower stratum at Mering's mill was spread out in a comparatively deep and quiet sea, while at Test's mills, at about the middle horizon, the sea was sufficiently shallow to disturb the shells in their stratification and separate the valves, but it was not sufficiently shallow to wear the shells or grind them to pieces, as would be done on a beach. Something like this last condition existed at or near Elkhorn Falls during the close of the Lower Silurian. A common fossil of a layer rather above our middle horizon is *Cypriocardites hainesi*. In the neighborhood of Mering's mill this fossil preserves all its concentric lines very beauti-

fully, while at Elkhorn Falls the same shell, though taken from the stratified rocks themselves, is worn so that it can often only be recognized by its general appearance and outline. Note these three things: At Mering's mill, lowest horizon, a sea deep enough to be quiet at the bottom; at Test's mills, rather below middle horizon, a sea sufficiently shallow to be disturbed at the bottom; at Elkhorn Falls, something like a beach. Such facts and deductions may be multiplied indefinitely within a radius of six miles, and a varying horizon of a few hundred feet.

Whence the well defined gorge, which extends from below Larsh's mill to Thistlethwaite's pond, has been the subject of much speculation. I cannot go over all the ground; all acknowledge the agency of water. I believe the falls now to be seen at the upper end of the gorge to be the chief key to the answer of the question. If this be true, how many a century has been scored in the stubborn rock by the water! How many another was marked by the slow growth of the rocks themselves!

"What oldest star the fame can save
Of races perishing to pave
The planet with a floor of lime."

KEY TO THE CLASSES.

- a Plant—See text book for definition.* b
- a Animal " " " c
- b But one class represented—Fucoids..... †
- c Articulata—See text book for definition..... d
- c Mollusca " " " e
- c Radiata " " " f
- d Trilobites—Body composed of three distinct lobes†
- d Ostracoids—bivalvular, very small, rare..... †
- d Annelids—parasitic on shells, very small, hornlike.. †
- e Cephalopoda—Body apparently composed of consecutive rings, straight or curved, not radiate at end or three lobed in any part †
- e Gasteropoda—Shell composed of one piece, univalve. †
- e Lamellibranchiata—Bivalvular, divided into unequal parts by median line..... †
- e Brachiopoda—Bivalvular, divided into equal parts by median line..... †
- e Pteropoda (Sig. Wingfooted)—Parts found conical or pyramidal—Tentaculites or Conularia. (See Dana's Manual, page 125). †
- e Bryozoa (Sig. Moss animal)—These resemble corals, are either branched, reticulating or incrusting forms. (See Dana's Manual, page 127)..... †
- f Echinoderms—Animals with calcareous exterior; sometimes furnished with spines, often growing on a stem. (Dana's Manual, page 127)..... †
- f Polyps—Animals that secrete ordinary coral..... †

*The fossil plants here bear no pores.

†See index.

†Fragments are to be found, 1st of pygidium (tail) and thorax, which indicate the three lobed structure more or less perfectly—2nd, of cephalic and caudal shields, which have no trace of the lobe.

KEY TO THE PLANTS.

Algæ—A term for sea plants in general.

Fucoids—Those algæ related to the tough, leathery sea-weeds called *Fuci*.

a Branched.....*Buthotrophis*.

a Not branched.....*Palæophyceus*.

Buthotrophis—(Sig. growing in the depths of the sea.)

1. Stems slender; hardly a line in diameter, *flattened*, branched sub-dichotomously; sometimes opposite, sometimes alternate; no markings.

Sig.—Slender. *B. gracilis*.

*Hall I. Hall.

2. Stems thick, subcylindrical, branching: specimens at hand from $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter.

Sig.—Sappy. *B. succulens*.

Hall I. Hall.

Palæophyceus (Sig. Ancient seaweed).

1. Stem simple cylindrical, or sometimes flattened from compression, often grooved on one side, surface otherwise smooth; common.

Sig.—Not branched. *P. simplex*.

Hall I. Hall.

NOTE.—One Protozoan, a sponge, has been found by Mr. Case, but it belongs in the drift, and is not therefore described.

*Means specimens described in *Palæontology of N. Y.*, Vol. I.

POLYPS.

NECESSARY DEFINITIONS:

Coralites—The separate columns of which the coral structure is made up.

Calices—Cups at the top of coralites.

Corallum—A term applied to the frame-work which gives shape to the coralites in general; it is spoken of as ramosc, frondescnt, lamellar, massive, etc.

Septa—Longitudinal divisions.

Tabulae—Transverse divisions. These may be seen in linear section.

Walls—Divisions between the calices.

Epitheca—The basal covering of the corallum.

NOTE—The study of Polyps cannot be successfully carried on without a magnifier, and the best is the small glass used for counting the threads in linen, as it has an opening three lines square, and by means of this the coralites can be measured.

Analytical Key to the Genera of the Class Polyps.

1. Horn-like.....	Streptelasma (Petraia)
1. Not hornlike.....	2
2. Parasitic.....	3
2. Not parasitic.....	4
3. Cobweb-like	Aulopora.
3. Not cobweb-like.....	5

-
5. Coralites, coarse, $\frac{1}{4}$ of a line in diameter.....*Protarea*.
 5. Coralites, fine.....*Monticulipora (Chaetetes)*.
 4. Massive 6
 4. Branching, or frondescent 7
 6. Coralline structure, indistinct; growing by concentric, wrinkled layers.....*Stromatocerium*.
 6. Surface papillose, coralites very small, 12 to the line.....*Monticulipora*.
 6. Surface not papillose, coralites small—about 4 to the line, giving fibrous appearance in linear section.....*Tetradium*.
 6. Surface not papillose; coralites large, $1\frac{1}{2}$ lines in diameter..... 8
 8. Thin walled; stellate within the calices; crossed by transverse lines (tabulae) in linear section. (Favistella.)
 8. Walls double and dotted, (mural pores,) so as to be sieve-like in linear section.....*Columnopora*.
 7. Papillose elevations stellate.....*Stelliopora*.
 7. Not stellate.....*Monticulipora*.
Monticulipora (Ety. *Monticulus* a hillock; *poros* a pore.)
 1. Corallum dichotomously branching at short intervals; cylindrical, or elliptical before branching, calices polygonal; surface covered with conical sharply pointed prominences arranged in irregular diagonal lines; many minute coralites between the larger ones.

Sig.—Proper name.

M. dalei.

*O. II.

Edwards and Haime.

2. Surface marked by elevations lengthened transversely so as to give the appearance of a transverse ridge; these vary in length but do not pass entirely around the stem; in other respects similar to *M. dalei*.

Sig.—Wrinkled.

M. rugosa.

O. II.

E. and H.

*O. II. means specimens described in Ohio Reports, Vol. 2.

3. Surface eminences very slight, not sharp pointed and covered with smaller coralites or none; *few* minute coralites between larger ones; in other respects similar to *M. dalei*.

M. approximata.

Nicholson.

- O. II.
4. Corallum frondescent, lamellar, mammillated tubercles prominent, well marked, and corresponding to *M. dalei* of the ramose series. Coralites at foot of tubercles larger and those on the apex smaller than the average.

Sig.—Covered with nipples.

M. mammillata.

O. II.

D'Orbigny.

5. Not tuberculous; sometimes branching from a nodulous center; surface, marked at distances of about half a line by groups of five or more coralites, two or three times the size of the average.

Sig.—Beautiful.

M. pulchella (?)

O. II.

Edwards and Haime.

NOTE.—S. A. Miller thinks *M. pulchella* does not occur in this country. I cannot tell; we have a coral which answers the description, and I call it this according to the Ohio Reports.

6. Corallum smooth, branching dichotomously at an acute angle, cylindrical; calices oval, equal in size, with thickened walls and opening on the surface somewhat obliquely, with interstitial tubuli.

Sig.—Slender.

M. gracilis.

O. II.

Nicholson.

7. Corallum less than a line in diameter, delicate, generally branched, often seeming to rise from a rootstock; calices quite oblique and lengthened longitudinally, without interstitial tubuli.

Sig.—Delicate.

M. delicatula.

O. II.

Nicholson.

-
- 8. Easily determined by its rounded coralites and unusually thick walls; common at Crawford's mills; ramosc; sometimes a lobate mass; often nodulous; no tubercles. *M. Jamesi.*
Sig—Proper name. *Nicholson.*
O. II.
 - 9. Corallum ramosc; coralites thin walled, sometimes hexagonal, but often rhombic, and arranged in diagonal rows, which change direction frequently, giving surface a strange appearance. *M. quadrata.*
Sig—Four-cornered. *Rominger.*
O. II.
 - 10. Corallum generally free; concave below, *conical* above; height one-half the diameter; surface covered with obtuse tuberosities; these are sometimes worn away and large coralites take their place; epitheca concentrically wrinkled. *M. petropolytanus.*
O. II. *Pander.*
See note to 5.
 - 11. Corallum concave below, *convex* above; two lines thick; surface not covered with tuberosities; coralites equal in size; not as high as preceding; epitheca nearly smooth. *M. discoidea.*
Sig—Circular. *Nicholson.*
O. II.
 - 12. Corallum flattened, undulating, leaf-like; less than a line thick; polyp-bearing on both sides; low, conical tubercles generally present; interstitial tubuli easily seen with small power. *M. frondosa.*
Sig—Leaf-like. *D'Orbigny.*
O. II.
 - 13. Corallum crustlike, thin, parasitic, generally circular; surface marked by many small conical eminences,

compact at their summit; calices sub-polygonal, about equal.

M. ortoni.

Sig—Proper name.

Nicholson.

O. II.

14. Corallum parasitic; thin, surface bearing many long narrow tubercles, lengthened in one direction and arranged in diagonal lines; coralites thin walled, polygonal, subequal, about eight in one line.

Sig—Tubercular.

M. tuberculata.

O. II., as *Chaetetes corticans*. Edwards and Haime.

15. Resembles *M. delicatula*, but differs from it in bearing groups of coralites of a larger size than the average. Differs from *M. pulchella* in the respects in which it agrees with *M. delicatula*, and also the large-sized coralites are not so conspicuously large as in *M. pulchella*.

M. fletcheri.

Sig—Proper name.

Edwards and Haime.

O. II.

NOTE.—We have a species of *Monticulipora*, one of our most characteristic, for which I have seen no description. It has a strongly wrinkled epitheca, grows by concentrically wrinkled layers. The inside is not unlike fig. 8 b, Palaeontology of Ill., Vol. 3, but the upper side of that specimen, fig. 8 a, is not at all like ours, nor does the description suit. The same is true of both figure and description in the Palaeontology of New York, Vol. 1. The Illinois report gives $2\frac{1}{2}$ inches as the largest size of their specimen, but it is not uncommon to find specimens here six inches in diameter. The Illinois report describes the specimen under the name of *M. petropolytanus*, but I have already used that name once doubtfully, according to the Ohio reports. The Illinois specimen already has six names. I will describe ours, provisionally under another name.

16. Corallum massive; irregularly convex above, some-

times nodulous as if tending to branch, concave or flat below; surface marked by many sharp tubercles rather less than a line apart, strongly resembling those of *M. dalei*, but covered at top with small coralites or none; height of tubercles, half a line; size, etc., given in note above.

M. indianaensis.

Protarea (Ety. *proto*, first and *araios*, spongy.)

1. Parasitic, thin, without tubercles; calices hexagonal, about equal, one line in diameter; walls thick; cup shallow; incrusts many different shells; common.

Sig.—Ancient.

P. vetusta.

H. I. O. II.

Hall.

Favistella (Ety. *favus*, honeycomb and *stella*, star.)

1. Corallum massive; coralites hexagonal or pentagonal, walls united, septa alternately large and small; the large reach nearly or quite to the center, giving the interior of coralites a stellate appearance from above; tabulae complete.

Sig.—Starred.

F. stellata.

O. II.

Hall.

Columnopora (Ety. *columna*, a column; *pora*, pore.)

1. Septa distinct, of same size, but not reaching the center; between each pair is a row of mural pores, so that the walls of coralites have a sieve-like appearance; corallum massive; walls united; coralites large.

Sig.—Sieve formed.

C. cribiformis.

O. II.

Nicholson.

Tetradium. (Ety. *tetras* four.)

1. Corallum massive; coralites so small as to give fibrous appearance in linear section; easily identified by this feature; tabulae showing transverse lines in linear section; not tubercular.

Sig.—Threaded.

T. fibratum.

Amer. Jour. Sci., Vol. 22.

Safford.

Streptelasma (Ety. *streptos*, twisted; *elasma*, lamella.)

1. Horn shaped; easily identified by this alone; cup deep; septa numerous, manifest; horn sometimes six inches long; often marked by concentric wrinkles exteriorly.
Sig.—A little horn. S. corniculum.
Hall I. Hall.

NOTE.—Hall describes it has $\frac{2}{3}$ to $1\frac{1}{2}$ inches long. If that were the limits of *S. corniculum* our specimen could not be that, as it is often six inches long or more.

Stellipora (Ety. *Stella*, a star and *poros*, a pore.)

Corallum ramosc and frondescent, covered with star-shaped elevations, irregularly disposed; number of radiations generally seven; coralites between elevations circular, with thick walls; coralites on elevations smaller, with thin walls.

Sig.—Like the coral *Anthelia*. S. antheloidea.

Hall I. O. II. Hall.

Stromatocerium (Sig.—Honey-comb layer.)

Hemispherical; wrinkled layers about two or three lines thick; slight appearance of coralites transverse to layers; each separate lamina covered with conical tubercles about one inch apart; often $\frac{1}{2}$ inch in diameter at base and about as high.

Sig.—Wrinkled. S. rugosum.

Hall I. Hall.

Aulopora (Ety. *aulos*, pipe; *poros*, pore.)

1. Parasitic, arachnoid, diffusely branched, and anastomosing; tubes narrow, bearing a single row of pores; distinguished from *Alecto* by the uniform size of the tubes and the cell mouths rising perpendicularly from the tube.

Sig.—Cobweb-like. A. arachnoidea.

○ II Hall

Favosites—(Ety. *favus*, honey comb).

1. An Upper Silurian specimen. Coralites uniform in size, prismatic, large, from one to two lines in diameter; tabulae complete, septa absent; mural pores in two rows on each side of the prismatic column; these are often obscured.

F. gothlandicus.

Lamarch.

NOTE.—The specimens of chain coral I have seen are so poor it is not possible to detect the specific characters.

ECHINODERMATA.

NECESSARY DEFINITIONS.

Column—The stem on which the crinoid grows.

Basal Pieces—The pieces resting on the column.

1st Radial Pieces—The pieces resting on the basal pieces.

2nd Radial Pieces—The pieces resting on the 1st radial pieces.

Pinnulae—Jointed appendages attached to the arms, as in *Glyptocrinus baeri*.

Radials—The large body pieces which make up the prominent angles, as in *G. baeri*.

Interradials—The pieces between the radials.

Key to the Genera of Echinoderms.

- 1 Crinoids—Animals growing on a stem, like a flower....b
- 1 Asteroids—Starfishes.....c
- 1 Crinoidea or Encrinites—Animals which have arms attached at the margin of the disk. The plates of the body have a regular radiate structure.....d
- 1 Cystidea—Plates not regularly radiate; arms, if any, proceeding from the center of the summit.....e
- 1 Agelocrinadæ—Plates many, petal-like: body spherical; one genus.. Agelocrinus.
- 1 Glyptocrinus—Interradials numerous and small; pinnulae present.

- d *Dendrocrinus*—Pinnulæ, none; no interradials.
- e *Lepadocrinus*—Convex on every part.
- e *Lichenocrinus*—Concave in center above.
- c *Palæaster*—Rays wide in proportion to the length; not flexible.
- c *Stenaster*—Rays long and narrow; flexible.
- Dendrocrinus* (Sig.—Tree-lily.)
- 1. Basal pieces, five, pentagonal; 1st radial five, hexagonal; regularly alternating with basal; 2d radial five, pentagonal, regularly alternating with first radial; 1st and 2d radials larger than basals; arms bifurcate after the fifth joint from the 2d radials; again after the ninth joint; again after the thirteenth; again after the eighteenth. Commonest crinoid of vicinity.
D. *polydactylus*.
Sig.—Many fingered. Shumard.
O. I.
- 2. Column strongly pentagonal; ventral portion prolonged much beyond the body—about as long as the arms—and consisting of a net-work of costæ, with zig-zag appearance; base prominent at sutures and excavated in the middle of the pieces; 1st radial pieces convex in middle, from which point ridges extend out to meet other ridges from other pieces; body covered between these ridges by triangular excavations. Name in honor of L. B. Case, Esq.
D. *casei*.
O. I. Meek.
Glyptocrinus (Sig. Sculptured lily).
- 1. Column round; arms 10, large; body plates smooth; interradial spaces not distinctly excavated; pinnulæ almost touching, stronger than in the following; name in honor of Dr. O. P. Baer.
G. *baeri*.
O. I. Meek.

2. Arms 20; the 10 radiations bifurcate after giving off pinnulæ; arms smaller than in *G. baeri*; interradial spaces strongly excavated; pinnulæ separate.

Sig.—Proper name. *G. nealli.*

O. I. *Hall.*

Lichenocrinus—(Sig. Tree-moss-lily).

1. Small, discoidal; surface on which stem is attached convex with a depression in the center; this surface is covered with many small tuberculated plates; the other surface conforms to the body to which it is attached; locality, Hill's mills.

Sig.—Tuberculated. *L. tuberculatus.*

Cin. Quar. Jour. Sci., Vol. I. *S. A. Miller.*

2. Similar to 1 in shape, size, etc.; distinguished from that by its smooth plates; the plates are often removed and the radial structure—about 100 rays—is seen below.

Sig.—Basin shaped. *L. crateriformis.*

O. I. *Hall.*

Lepadocrinus (Sig.—Barnacle-lily.)

1. Body obovate, $\frac{1}{2}$ inch long; ambulacral furrows at top, five; pectinated rhombs, four; column round near body, tapering rapidly, composed of thin segments; these are longer, remote from the body; rather common at Hill's mills. Name in honor of President Moore, of Earlham College. *L. moorei.*

O. I. *Meek.*

Agelocrinus (Sig.—A lily-herd.)

1. Body circular, parasitic; disc composed of many thin plates imbricating inward; easily recognized by this feature; rather less than one inch in diameter.

O. I. *A. cincinnatiensis.*
Roemer.

Stenaster—(Ety. *stenos*, narrow; *aster*, star.)

Rays widest at their connection with the body, and tapering gradually to the extremity; very flexible; dorsal side of body covered with numerous little tubercular sub-triangular plates. The only specimen found is in Mrs. Haines' collection, and is the specimen figured in the Palaeontology of Ohio. *S. grandis.*

Sig.—Large.

Meek.

Palæaster (Sig.—Ancient star.)

Rays one and one-half inch long; one-half inch wide near disc; sides of the rays parallel to within one-fourth of an inch of the end, from which point they taper to a rounded angle at the end; breadth of disc one inch. In other respects this specimen agrees very nearly with *P. granulosus* as described in the Palaeontology of Ohio, Vol. I. If it should be found to differ specifically from that, it might be called *P. parallelus*, in allusion to the parallelism of its rays.

Mr. Nordyke's collection.

NOTE.—Another species of Palæaster has been found here, but the specimen has been taken away, and so cannot be examined.

BRYOZOA.

NECESSARY DEFINITIONS.

Cœnœcium or Polyzoary.—The frame work which binds the collection of animals together, arachnoid, incrusting, etc.

Key to the Genera.

1. Stem-like, narrow, branching. *Ptilodictya*.
 1. Arachnoid *Alecto*.
 1. Expanded 2.
 2. Not tubercular; pores not elevated above the surface. *Ceramopora*.
 2. Tubes bearing pores rising from the surface. *Alecto*.
 2. Bearing tubercles. *Ptilodictya*.
- Alecto**—(Sig.—Mythological name.)
1. Parasitic, arachnoid, large at opening; contracting rapidly from the opening to the base of the cell; cell mouth smaller than the expanded end of the cell.
Sig. inflated. *A. inflata*.
O. II. *Hall*.
 2. Parasitic, arachnoid, cells tubular, not inflated, rising obliquely from the cœnœcium and partly immersed in it, but free at the opening; cells generally arranged in two rows.
Sig.—Like aulopora. *A. auloporoïdes*.
O. II. *Nicholson*.

3. Cells, etc., resembling 2, but the anastomosing branches are wider; often unite and form an expanded crust on which the cells are arranged in many rows, though often the branches are reticulating and the cells are then generally arranged in three rows.

Sig.—Spreading.

A. frondosa.

O. II.

James.

Ceramopora—(Sig.—Pores imbricated; roof-like.)

1. Common; parasitic, forming thin crusts without tubercles; no radiate structure in cells; cell mouths open obliquely to the encrustation; appearance is varied much by being worn, so that experience is necessary before it can be determined with certainty; six figures are given in Ohio Reports, Vol. II.

C. ohioensis.

Nicholson.

Ptilodictya (Sig.—A wing and a net).

1. Polyzoary, flattened, thin, delicate; less than a line wide; branching alternately at short intervals; branches as wide as main stem; pores without raised margins; arranged in alternating longitudinal lines; oval longitudinally.

Sig.—Proper name.

P. shafferi.

O. I.

Meek.

2. Polyzoary, narrow, linear, thin; branches dichotomously; easily distinguished by this last feature; cells elliptical; major axis in direction of branches; six to the line, measured longitudinally; arranged in longitudinal rows.

P. emacerata.

Nicholson.

O. II.

3. Polyzoary, expanded; specimens at hand one inch wide

and two inches long; surface exhibiting mammillary tubercles $1\frac{1}{2}$ lines apart, not bearing pores at apex; pores about 10 to the line, equal in size; opening obliquely to the surface; arranged in irregular lines; not before described or named; High School collection.

P. monticulifera.

BRACHIOPODA.

NECESSARY DEFINITIONS

Foramen—Small opening, generally circular, sometimes triangular, through which passed the organ of adhesion.

Cardinal Margin—**Hinge Margin**—**Posterior Margin**—synonymous terms for the margin bearing the beaks.

Anterior margin—Margin opposite the hinge margin.

Lateral margins—Margins to right and left as you face the cardinal margin or the anterior margin.

Ventral Valve—Valve bearing the foramen.

Dorsal Valve—Valve opposite the ventral.

Umbo—Rounded protuberance in the central posterior part of shell.

Beak—The pointed, projecting—often incurved—part of either valve in umbonal region.

Width—Dimension in the direction of hinge line.

Median line—Line drawn from umbo to middle of anterior margin.

Deltidium—Convex triangular prominence in the center of the articular portion of the valve.

Area—Term applied to the articular portion of either valve.

Key to the Genera of Brachiopoda.

- | | |
|------------------------|-----------|
| 1. Parasitic | 2 |
| 1. Not parasitic | 3 |
| 2. Punctate | Trematis. |

-
- | | |
|--|------------------|
| 2. Not punctate..... | 4 |
| 4. Beak, sub-central..... | Crania. |
| 4. Beak, marginal or indistinct..... | 5 |
| 5. Surface markings concentric or similar to surface markings of the shell on which it grows..... | Crania. |
| 5. Surface marked near beak by two small triangular impressions..... | Schizocrania. |
| 3. Punctate | Trematis. |
| 3. Not punctate..... | 6 |
| 6. Lateral margins forming an angle at umbo; hinge line not apparent..... | 7 |
| 6. Hinge line apparent, projecting at right angles to median line; each lateral margin forming an angle with hinge margin..... | 8 |
| 7. Very small—less than one-fourth inch long, orbicular..... | Zygospira. |
| 7. Larger; half inch long or more—trigonal; older specimens often swollen and globose.. | Rhynchonella. |
| 7. Very large, oblong—longer than wide..... | Pentamerus. |
| 8. Convexo-convex, or subplano-convex; ventral valve often only convex near umbo..... | 9 |
| 8. Convexo-concave; one valve convex in no part..... | 10 |
| 9. Thin, valves subequal, nearly evenly convex; both valves marked by four or more manifest ridges or rings of growth, ventral beak prominent..... | Streptorhynchus. |
| 9. Valves unequal, unequally convex, or if subequal thickened..... | Orthis. |
| 10. Area wide; deltidium and beak prominent..... | Streptorhynchus. |
| 10. Area narrow, deltidium and beak not prominent... | 11 |
| 11. Shell large, sometimes wrinkled concentrically.... | Strophomena. |
| 11. Shell small—about $\frac{1}{2}$ inch long—generally found in flags..... | Leptæna. |

Orthis—*Sig.*—Straight, in allusion to the straight hinge line.

1. Lateral extremities mucronate, hinge line extended so that sometimes shell is two, or at farthest three, times as wide as long, though sometimes it is only slightly or not at all prolonged beyond the width of the valves, often one side only is prolonged, or one is prolonged more than the other, and there is every gradation; becomes globose with age; plications fine, about thirty—forty on each valve. Sinus on ventral valve of three plications; corresponding elevation on dorsal valve of four plications, front sinuous.

O. biforata var. *acutilirata*.

Biforata—Having two foramina. Conrad.

Acutilirata—Sharply ridged.

O. I.

2. Dorsal valve more convex than ventral, and each has a shallow mesial sinus; sinus of ventral valve generally well marked in front and dying out toward *umbo*; beak of ventral valve prominent; margins sloping from beak to extremities of hinge line, making area triangular; area large; cardinal margin usually equaling, sometimes a little longer than width of shell. *Striae* straight. *O. occidentalis*.

Sig.—Western. Hall.

Hall. I. O. I.

3. Similar to preceding, except that there is *no dorsal sinus*, sometimes there is an elevation instead, and striae are generally coarser. *O. sinuata*.

Sig.—waved. Hall.

H. I. O. I.

4. Manifestly subquadrate, area small; striae near cardinal line turn upward and end in the cardinal line near its lateral extremities; dorsal valve marked by a

shallow mesial sinus, on each side of which it is evenly convex; ventral valve flat, with a slight convexity near beak; cardinal margin somewhat shorter than width of shell, and rounded at its extremities; striae bifurcate twice, once near beak and once near margin.

O. subquadrata.

Sig.—Somewhat quadrate.

Hall.

O. I. H. I.

5. Striae near cardinal line curve as in *O. subquadrata*; distinguished from it by its well-defined ridge on ventral valve, and its equally well-defined sinus on dorsal valve; both sinus and ridge are slight and equally prominent from beak to anterior margin; striae fine. Abundant at most places between Abing-ton and Brownsville. I have one specimen from near the old knife factory.

Sig.—Many divided. *O. emacerata*. var. *multisecta*.

O. I. James.

6. Similar to 1, but differing in the number and size of the plications; plications about sixteen. Locality, Hill's mills.

O. biforata var. *laticosta*.

Sig.—Broad ribbed. James.

O. I.

Rhynchonella—Sig.—Little Beak.

1. Small, about half inch or less *long* and *wide*, trigonal; lateral margins sharply zig-zag, sinus on ventral valve of one plication; sinus deep in front but dying out toward beak; corresponding elevation of two plications on dorsal valve; beak of dorsal valve in-curved under beak of ventral valve; foramen apparent; plications strong, simple.

Sig.—Toothed. *R. dentata*.

O. I. H. I. Hall.

2. Medium sized, about one inch long and wide, or less,

zig-zag lines of growth marked all over surface, shape much like preceding, but less angular; sinus composed of *three* plications; older specimens more globose than younger, distinguished from preceding by the well marked lines of growth and the number of plications in the sinus.

Sig.—Capacious.

R. capax.

O. I. H. I.

Conrad.

Zygospira.—From two words meaning a yoke and a spire.

1. Quite small, subplano-convex, orbicular, mesial sinus in dorsal valve; central plication largest; corresponding elevation in ventral valve of four plications, two on either side of a wider and deeper central furrow, easily found in highest strata south of old suspension bridge, west side; also at Hill's mills.

Sig.—Not large.

Z. modesta.

O. I. H. I. *Atrypa modesta.*

Say.

Pentamerus.—Sig.—Five apartments.

1. Casts of interior only, found; longer than wide; widest part just in front of middle; umbonal region marked by an incision, at right angles to the cardinal margin, which is double on dorsal valve and is generally filled with calcite; largest brachiopod of vicinity; locality *Middleboro*, Upper Silurian fossil.

Sig.—Oblong.

P. oblongus.

O. II. H. II.

Sowerby.

Streptorhynchus.—Twisted beak.

1. Convexo-convex, shell small, convexity slight, ventral valve only convex at umbo, marked by a sinus that renders it concave in front, both valves marked by four or five rather distinct lines of growth, *valves sub-equal*; dorsal valve flat on *umbo*; *shell thin*.

Sig.—Furrowed.

S. sulcatus.

O. I.

Verneuil.

2. Moderately large; width of a large one two inches, length one and a half inches; *lateral margins a little sinuous posteriorly*; area of ventral valve one-fourth inch broad at umbo, tapering to extremities so as to be triangular; varies, however, to nearly linear; ventral valve concave, flat in umbonal region; deltidium convex, triangular, with the inner margin sinuous, prominent; interior of dorsal valve marked by four manifest ridges, with a fine plication in each intervening sinus; entire inner surface generally marked by granulations; v. v. easily recognized by the broad triangular area, the deltidium *and its size*.

Sig.—*Woven*, in allusion to the cross-markings of surface.

O. I. *Strophomena filitexta*. S. *filitextus*.

H. I. *Leptaena filitexta*. Hall.

3. Distinguished from preceding, which it closely resembles externally by its smaller size (width about one inch, length four-fifths of an inch) and *internal characters; no plications in dorsal valve*; interior margin of ventral valve thickened and roughened by vascular markings.

S. *planumbonus*.

Hall.

O. I. *Strophomena planumbona*.

H. I. *Leptaena planumbona*.

4. Internal characters similar to 2; similar to both 1 and 2 externally, but differing in size (width one and a half inches, length one inch), and more extended laterally than either, so as to render the angle of the cardinal margin with the lateral, plainly acute.

Sig.—(Somewhat bent.) S. *subtentus*.

O. I. *Strophomena plicata*. Conrad.

H. I. *Leptaena subtenta*.

Leptaena.—Sig.—Thin.

1. Shell small, semi-oval; length to breadth as 3 to 5½;

usually found in slabs; surface shining, hinge-line longer than breadth of valves at any point farther forward; dorsal valve concave; ventral convex; cavity within, thin.

L. sericea.

Sig.—Silky.

Sowerby.

O. I. H. I.

Strophomena.—From a word meaning bent and one meaning crescent.

* Wrinkled concentrically.

1. Shell medium sized, both valves flattened and concentrically wrinkled; easily distinguished from all other home fossils by this feature; locality Elkhorn Creek and Crawford's mills.

Sig.—Wrinkled. *S. rhomboidalis* (Wah.) var. *rugosa*.

O. I.

Dalman.

** Not wrinkled concentrically.

1. Shell attaining a large size, usually broader than long, dorsal valve concave, beak small, area narrow and projected backward; interior marked by two triangular prominences (cardinal process divided) divergent from beak, and by a thickened, wrinkled ridge around the front and lateral margins; ventral valve convex; striae arranged with from four to six smaller between two larger ones.

S. alternata.

Sig.—Alternating.

Conrad.

O. I.

H. I. *Leptæna alternata*.

2. Similar to preceding, but striae uniform on ventral valve; on dorsal valve one larger plication, alternating with smaller. *S. alternata*; var. *alternastriata*.

Sig.—Striae alternating.

Hall.

O. I. H. I.

Trematis—An opening.

1. Shell small; $\frac{3}{4}$ inch long, rather wider, outer surface

punctate; inner punctate if exfoliate; valves marked by about six semi-circular rings of growth.

Sig.—Many dotted. *T. millepunctata.*

O. II. *Hall.*

Crania—Upper part of skull.

1. Shell small, discoid, marked by circular lamellose lines of growth; but this feature is often obscure, and the surface features are often similar to the surface features of the shell on which it grows; striae of parasite and parent body running in the same direction if parent body is at all rough; beak sub-central or indistinct. *C. scabiosa.*

Sig.—Scabby. *Hall.*

O. II.

(See Addenda.).

2. Size, etc., same as preceding; distinguished from it by the small, pointed, manifest apex of dorsal valve, situated a little out of center, and the fine radiating sharply elevated striae, extending from the apex to margin in every direction; v. v. of this and the preceding concealed between the dorsal valve and the parent body. *C. laelia.*

Sig.—Proper name. *Hall.*

O. II.

Schizocrania—*Schiza*, a cleft; *crania*, skull.

Shell small, longer than wide, moderately convex, the exfoliated, convex, free portion marked by two triangular muscular scars near beak—the distinguishing feature of the genus. When not exfoliate it is marked externally by fine radial striae and concentric lines of growth. *S. filosa.*

Sig.—Thread-like.

O. II. *H. I.*

PTEROPODA.

Key to the Genera.

- a Tentaculites.—Conical.
- a Conularia Pyramidal or flat from compression.
Tentaculites—(Ety. *tentaculum*, a feeler and *lithos*, stone.
 1. Conical, free, straight, concave at larger end; surface marked by strong constrictions, about two to the line at larger end, and four to the line at smaller end, so as to seem made up of ring like segments; fine longitudinal lines cross these; length about one inch.
Sig.—Proper name. T. richmondensis.
Cin. Quar. Jour. of Sci., Vol. II. S. A. Miller.
 - Conularia—(Sig.—Little Cone.)
 1. Pyramidal, grooved at the angles; three inches long; greatest perimeter 2 7-10 inches; surface marked by papillose lines slightly concave to the apex; these elevations seem to be produced by longitudinal and transverse lines crossing each other; transverse lines about 240 to the inch; the longitudinal are somewhat finer.
Sig.—Covered with papilli. C. papillata.
H. I. Hall.
 2. Pyramidal; surface marked by granulations, two to the line longitudinally, and three to the line transversely; granulations rounded; produced by transverse and longitudinal lines, which meet about at right angles;.

the transverse are oblique to the angles of the pyramid; and the longitudinal are oblique to the perimeter; obliquity of each 10 degrees; length unknown; the fragment found is $3\frac{1}{2}$ inches long. The specimen is not described in any book to which I have access, and so I provisionally name it in honor of Joseph Doan, who found it on John's Creek, Ab. Tp.

C. doani.

GASTEROPODA.

NECESSARY DEFINITIONS.

Aperture.—Opening into shell.

Whorls.—The different spiral turns.

Body Whorl.—The newest and hence the largest whorl of the spire.

Spire.—Term applied to the whorls taken together.

Columella.—Axis around which the whorls revolve.

Apex.—Pointed end of spire.

Umbilicus.—Opening at the base of the *columella*.

Sutures.—Lines separating the whorls.

Lines of Growth.—Lines extending from one suture to another.

Revolving Lines and Furrows.—Markings parallel to the sutures.

Keeled.—A shell is keeled when the whorls are marked by a sharp elevation; usually the keel is midway between the sutures.

Sculptured.—A shell is sculptured when it is marked with broad, regularly recurring elevations and depressions.

Length.—Dimension in direction of spire.

Width.—Diameter of base.

Analytical Key to the Genera of Gasteropoda.

- | | |
|--|---|
| 1. Depressed; whorls in same plane..... | 2 |
| 1. Conical; whorls not in same plane | 3 |

1. Not coiled; limpet-like *Carinaropsis*.
 2. Large, trumpet-shaped, volutions gradually increasing in size, all visible, concave on both sides....*Bucania*.
 2. Smaller, volutions invisible; few whorled, sometimes keeled; smooth or marked by fine lines; not sculptured.....*Bellerophon*.
 2. Whorls keeled dorsally; sculptured obliquely; shell small; aperture not alate.....*Cyrtolites*.
 2. Spire flat.....*Raphistoma*.
 3. Spire elongated; whorls several; diameter of base from one-half to one-fifth as great as height of spire. *Murchisonia*.
 3. Not casts; width and height about equal; whorls not keeled*Cyclonema*.
 3. Casts; height sometimes less than width, sometimes equaling the width.....*Pleurotomaria*.
Carinaropsis--(Sig. Resembling *Carinaria*.)
 1. Rare; limpet-like; apex half way between center and margin; major axis to minor as 9 to 7; surface marked by four concentric lines. *C. patelliformis*.
 Sig.—Shaped like a patella. *Hall*.
 H. I.
Cyclonema—Ety.—*kuklos*, a circle, *nema*, a thread.
 1. Shell small, $\frac{1}{2}$ inch long, width usually a little less; conical, volutions about four, surface beautifully marked by revolving lines, crossed by fine, thread-like lines of growth; aperture rounded; shell variable, with three separated varieties. This and the three following varieties are the only gasteropods of the vicinity, preserving the shell. *C. bilix*.
 Sig.—Woven. *Conrad*.
 O. I. H. I. *Pleurotomaria bilix*.
 2. Large, width $1\frac{1}{2}$ in., height slightly less, body whorl, occupying about $\frac{2}{3}$ of the length; shell slightly concave

on lower side, convex on upper; distinguished from parent type by size and proportional size of body whorl; suture shallow. *C. bilix*; var. *pyramidatum*.

Cin. Quar. Journ. of Sci., Vol. I. James.

3. Differs little from parent type; cone steeper; length one-fifth greater than width; an occasional irregular ridge extending in direction of the lines of growth; aperture subquadrate.
C. Q. J. S., Vol. I. *C. bilix*; var. *conicum*.
S. A. Miller.
4. Somewhat larger than 1; broader than high; surface marked by strong, rounded, oblique ridges and shallow sinuses on the upper slope of body whorl.
.Sig.—Broad. *C. bilix*, var. *latum*.
C. Q. J. S., Vol. I. Meek.
O. I.

Pleurotomaria.—Ety.—(*Pleura*, side; *tome*, notch.)

1. Rare; casts only found; lenticular; sutures very shallow; apex obtuse; shell small; scarcely $\frac{1}{4}$ inch long.
See Addenda. *P. lenticularis*.
Sig.—Lens-shaped. Hall.
Hall I.
2. Common; casts or impressions only found; or shell covered with coral if present; keeled dorsally, keel widening and becoming bandlike on body whorl; apex much more acute than preceding; surface striae extending backward from suture to keel; length $1\frac{3}{4}$ inches; width $1\frac{1}{2}$ inches.
Sig.—Nearly cone-shaped. *P. subconica*.
Hall I. Hall.
Bucania.—(*Bucane*, a trumpet.)
1. Convolute; volutions three; all visible, trumpet-shaped; casts only found; concave on both sides; keeled dorsally; keel commencing at base of last volution and

growing stronger toward aperture; aperture abruptly expanding; shell large; sometimes three inches in greatest dimension—from outer lip to farthest periphery.

Sig.—Expanding.

B. expansa.

Hall I.

Hall.

Bellerophon.—(Sig.—A name from mythology.)

1. Involute; keeled dorsally; inner lip alate on both sides, so that the diameter of the aperture, measured across the inner margin, is twice as great as the diameter of whorl adjacent; shell smooth.

Sig.—Proper name.

B. mohri.

Cin. Jour. of Sci., Vol I.

S. A. Miller.

2. Involute; smooth; neither keeled nor sculptured; fine lines rising from umbilicus and forming an arch, rarely to be seen in casts; small; specimens casts; aperture two lobed.

B. bilobatus.

Sig.—Two lobed.

Sowerby.

Cyrtolites.—(Curved stone.)

1. Convolute; volutions two or three; strongly keeled dorsally; a ventral depression receives the dorsal keel; less strongly keeled or only angulated on the sides; sculptured; ridges extending from dorsal keel slightly forward to lateral angles. Shell is also finely striated parallel to these.

Sig.—Ornamented.

C. ornatus.

O. I. H. I.

Conrad.

2. Three lines from outer aperture to farthest periphery; small; periphery keeled; surface marked by about ten revolving ridges on each side; and numerous crowded, raised transverse lines between each two revolving ridges.

Sig.—Proper name.

C. dyeri.

O. I.

Hall.

Murchisonia.—(Proper name.)

1. *Rage*; length to width as 5 to 1; elongated, slender, volutions quite gradually increasing in size; spire quite acute. A delicate specimen.

Sig.—Slender.

M. gracilis.

Hall I.

Hall.

2. Often flattened so as to be elliptical in transverse section; large, elongated, length to width about as 2 to 1; sutures deep; whorls ventricose, not carinated, angle of spire more acute than in *P. subconica*. Specimens casts; surface smooth.

M. bellicincta.

Hall.

Sig.—Beautifully banded; in allusion to markings not shown in casts.

H. I.

3. Spire long, acute, volutions rapidly diminishing in size, strongly angular on the middle, except the last one, which is somewhat ventricose.

Sig.—Strongly angled.

M. perangulata.

Hall I.

Hall.

Rhaphistoma—(Ety.—*raphe*, seam; *stoma*, mouth.)

1. *Plano-convex*, whorls about three; greatest diameter $\frac{3}{4}$ inch; aperture unknown; the convex side bears a small umbilicus in the center, caused by the enlargement of the outer volutions; the whorls abruptly decline on the convex side toward the umbilicus, but are ventricose toward the periphery. Not before described.

Raphistoma (?) planispira.

Sig.—Spire flat.

LAMELLIBRANCHIATA.

NECESSARY DEFINITIONS.

Umbo—Same as for brachiopoda.

Beak—Same as for brachiopoda.

Anterior Region } The umbo is always between the
Posterior Region } anterior and posterior part and is
nearer to the anterior.

Cardinal Margin—Same as hinge margin—the straight part of the margin just behind the beaks.

Right Valve—The one bearing the umbo to the right of the middle as you face the convex side.

Left Valve—Valve bearing the umbo on the left of the middle as you face the convex side.

Basal Region—Region opposite the hinge.

Ventral Region—Same as basal region; that part of shell which was next the ground as the animal moved along.

Height—Dimension at right angles to base.

Length—Dimension parallel to base.

Dorsal region—Region behind the umbo, generally sub-parallel to the base; it includes the hinge.

Byssal Opening—Opening usually just in front of umbo for the passage of the *byssus*.

Umbonal Ridge—Elevated, thickened part of shell, extending from umbo to some part of base.

Pallial Line—Line within the shell parallel to the margin where the pallium was attached; this is exterior (on the convex surface) in casts.

Lines of Growth—Concentric lines, usually about parallel with the anterior, basal and posterior margins of shell.

Radial Lines—Lines extending from umbo to margins, transverse to lines of growth.

Analytical Key to the Genera of Lamellibranchiata.

1. Beaks extending farther forward than any other part of shell 2
1. Beaks not extending farther forward than any other part of shell 3
2. Distinctly cordate as seen from above, below or in front.....*Cypriocardites*.
2. Not distinctly cordate 4
4. Very large, four inches from beak to posterior base; umbonal ridge rounded to anterior part of valves; rare*Anomalodonta*.
4. Less than *Anomalodonta*, medium sized, or if at all large, umbonal ridge abruptly declining to atnerior margin.
.....*Ambonychia*.
3. Casts 5
3. Not casts 6
5. Muscular impressions (in casts elevations) prominent below beaks 7
5. Muscular impressions not prominent below beaks.
.....*Cypriocardites*.
7. Much longer than high; medium sized 8
7. Orbicular, small*Tellinomya*.
8. Hinge line and margin arcuate*Modiolopsis*.
8. Hinge line straight*Orthodesma*.
6. Lines of growth distinctly lamellar on body, crowded in cardinal region, valves unequal, thin*Avicula*.
6. Lines of growth not lamellar, shell more robust; valves equal*Cypicarites*.

Ambonychia—(Ety.—*ambon*, boss of a shield; *onyx*, a claw.)

1. Common; beaks incurved, extending beyond the hinge line; byssal opening circular, large compared with size of the shell; outline varying from subquadangular with a rounded base to ovate, with acute apex, caused by varying angle of shell to hinge line; surface marked by strong radiating ribs; medium sized; highest horizon.
A. radiata.
Sig.—Radiated. Hall.
H. I.
2. Hinge line longest dimension rendering shell strongly alate; shell thin, triangular; surface showing both marks of growth and radiating ribs; umbonal ridge extending to the point of greatest height, which is rather in front of middle.
A. casei.
Sig.—Proper name. M. and W.
O. I.
3. More ventricose than either of preceding: anterior margin abruptly declining from beaks, and rounded below. In the umbonal region each valve forms a well defined angle by suddenly declining toward the union of the two valves; shell attaining a large size.
A. carinata.
Sig.—Keeled. Goldfuss.
H. I.
4. Suborbicular; ventricose in middle and umbonal parts; compressed and alate behind; casts sometimes show both radiating ribs and also concentric lines; again, they are smooth, and preserve a large, circular, muscular impression just posterior to the middle of the shell.
A. orbicularis.
Sig.—Orb-shaped. Emmons.
H. I.
5. Base regularly rounded; surface marked by fine radi-

ating striae, with some well marked lines of growth at equal intervals; height much greater than length; umbo ventricose; beaks incurved. A. ——(?)

Tellinomya—(Ety.—*telline*, a sort of mussel, and *Mya*, a genus of shells.)

1. Small, subcircular, regularly rounded in front and below; projected a little backward below the middle so as to be slightly oblique; convexity slight, shell thin, pallial line and muscular impressions well marked; hinge bearing twelve teeth; locality, Hill's mills.

Sig.—Like pentunculus. T. pectunculoides.

O. II. Hall.

Orthodesma—(Ety.—*orthos*, straight; *desma*, ligament.)

1. Elongate, about one-third as high as long; posterior part longest near base, from which it is obliquely truncate to cardinal margin; anterior end of cast suddenly contracted and rounded about the muscular impressions, which are quite in front of the beaks; hinge line long and straight and sub-parallel to the base behind the beaks. O. rectum.

Sig.—Straight. Hall and Whitfield.

O. II.

2. Subtrapezoidal; base sinuate just in front of middle and behind the beaks; umbonal ridge sharp, almost carinate, arcuate; dorsal region thick.

Sig.—Contracted. O. contractum.

H. I. Hall.

Modiolopsis—(Sig.—Resembling *Modiola*. a genus of shells.)

1. Pallial line distinct; muscular elevations (in casts) prominent, below and slightly anterior to beaks; valves crossed by sulci, extending from just in front of the beaks obliquely backward. These reach the base, but become indistinct near it, just in front of

middle, and so render basal margin sinuate; dorsal margin arcuate, about twice as long as high.

Sig.—Like *Modiola*. *M. modiolaris*.

H. I. *O. II.* Conrad.

2. Smaller than 1; muscular impressions farther forward; surface marked by fine concentric lines, which widen and deepen into shallow furrows in the dorsal region and become dimmer in the region of the umbonal ridge; this ridge is so evenly convex as not to be well marked; upper margin arcuate; pallial line not distinct. *M. concentrica*.

Sig.—Concentric. Hall and Whitfield.

O. II.

Anomalodonta—(Sig.—Strangely toothed.)

1. Very large; largest Lamellibranch of the Cin. group; hinge line marked by from 4 to 18 cartilage grooves, extending from cardinal tooth to posterior end of hinge; shell one inch thick in the umbonal region; radial ribs very coarse. *A. gigantea*.

Sig.—Large. *S. A. Miller*.

Cin. Quar. Jour. of Science, Vol. I.

Cypocardites—(Sig.—Resembling *Cypocardia*.)

1. Length a little greater than the height, which is not far from one inch in the average adult specimen; umbonal ridge strongly marked in umbonal region; it becomes less angular, and dies out toward the base; lines of growth distinct, fine, 7 to the line; shell highest just posterior to the middle, caused by the strong angle, 45 degrees, between the hinge line and umbonal ridge. A very beautiful shell, the only Lamellibranch of vicinity which preserves the shell well. Name in honor of Mrs. M. P. Haines. *C. hainesi*.

Cin. Jour. of Sci., Vol. I. *S. A. M.*

(See Addenda.)



2. Heart-shaped in front from above and below; height greater than thickness; each valve marked by a muscular impression behind the hinge, and one in front below the umbo; casts; larger than the following (near three inches long); umbonal ridges well marked but not so angular as in the following; compression above the ridges strong, but not so strong as in the following. *C. sterlingensis.*

Sig.—Proper name.

M. and W.

O. I.

3. Resembles 2 in outline; height less than thickness; muscular impressions not well defined; umbonal ridge very angular; compression at right angles near umbo and only a little less posteriorly, so that the cast will readily lie hinge downward; beaks farthest forward, which is not true of *C. sterlingensis.*

Sig.—Bulging out.

C. islandicus.

H. I.

Hall.

Avicula—(Sig.—A little bird.)

1. Oblliquely subovate, compressed, broadly alate behind, large, often three or four inches from umbo to middle of base; surface marked by close, sharp, concentric, lamellar striae, which give it a roughened appearance exteriorly. *A. demissa.*

Sig.—Hanging down.

Conrad.

H. I.

O. I. *Pterinea demissa.*

2. Smaller than 1 and more convex, on account of better marked umbonal ridge; lamellar striae wider; obliquely sub-rhomboidal; depressed. *A. insueta.*

Sig.—Unusual.

Emmons.

H. I.

(See Addenda—3.)

CEPHALOPODA.

Key to the Genera.

- | | | | |
|---|-------|--------------|---|
| 1. Straight..... | ..... | ..... | 2 |
| 1. Not straight..... | ..... | ..... | 3 |
| 2. Conical..... | ..... | ..... | 4 |
| 2. Tapering each way from near the middle of the outer chamber..... | ..... | Gomphoceras. | |
| 4. Siphuncle, simple, central,..... | ..... | Orthoceras. | |
| 4. Siphuncle, chainlike,..... | ..... | Ormoceras. | |
| 4. Siphuncle not chainlike, eccentric or submarginal. | | Endoceras. | |
| 3. Coiled into whorls..... | ..... | Trochoceras. | |
| 3. Curved but not coiled..... | ..... | Cyrtoceras. | |
| Orthoceras—(Sig.—Straight-horned.) | | | |
| 1. Slender, cylindrical, tapering gradually; septa distant; outer chamber deep; surface finely striated transversely. | | O. junceum. | |
| Sig.—Like a rush stem. | | Hall. | |
| H. I. | | | |
| 2. Cylindrical, very gradually tapering, annulated with abruptly elevated angular ridges distant about one-fourth the diameter of the tube. | | O. olorus. | |
| Sig.—Mythological name. | | Hall. | |
| H. I. | | | |
| NOTE.—There are several other species represented here, but only by small, imperfectly preserved fragments; they are not yet satisfactorily determined. | | | |

Ormoceras—(Sig.—A chain-like horn, in allusion to the siphuncle.)

1. Siphuncle annulated at the junction of the septa; expansion of the siphuncle within the concavity of each septum; contraction of siphuncle just above the convexity. This specimen presents many very different phases. See Palaeontology of N. Y., Vol. I.
Mrs. Haines' collection. O. tenuiflum.
Sig.—Fine lined, Hall.
H. I.

Gomphoceras—(Sig.—A club-shaped horn.)

1. Size unknown. Fragments are found five inches long and three inches in diameter at the largest part—the middle of the outer chamber—from which point the specimen tapers gradually forward and backward. The outer chamber forms about one-third of the length of the specimen. G. eos.
Sig.—The dawn. Hall and Whitfield.
O. II.

Trochoceras—(Sig.—Hoop-shaped horn.)

Rare; two rapidly enlarging volutions, coiled in the same plane; lateral diameter one-fourth wider than dorso-ventral; septa about one-third of an inch distant on the back; septa straight on the sides; slightly concave to the aperture dorsally.

Name in honor of Dr. O. P. Baer.—Mr. Webb's collection.
O. I. T. baeri.
Meek and Worthen.

Endoceras—(Sig.—Having a horn within.)

The most prominent feature is given in the meaning of the generic name: having a *horn within*; a very variable

species, as the specific name indicates. Young specimens taper to a very acute apex.

See cuts in Palæontology of N. Y., Vol. I.

Mr. Mote's collection.

Sig.--Having many shapes.

E. proteiforme.

Hall.

OSTRACOIDS.

But one specimen has been found here; that is in the cabinet of S. A. Miller, of Cincinnati. It is described in the Cin. Quar. Jour. of Sci., Vol. I.

It is very small; $\frac{1}{16}$ of an inch long; $\frac{2}{15}$ of an inch wide; is marked by an eye tubercle as high as the width, situated near the anterior part. As I have no specimen, the student is referred to the description cited above.

Beyrichia chambersi.

Sig.—Proper name.

S. A. Miller.

ANNELIDS.

But one genus represented.

Conchicolites—(Sig. Dwelling in a shell of stone.)

Parasitic on shells, coral, etc.; conical or horn-like; less than a line long, about $\frac{1}{2}$ of a line wide at larger end, marked by several transverse constrictions; cup about $\frac{1}{2}$ as deep as the length of the specimen.

C. minor.

Sig.—Less.

Nicholson.

Lond. Geo. Mag., Vol. X.

TRILOBITES.

NECESSARY DEFINITIONS.

Lobe—One of the three longitudinal divisions.

Segment—One of the transverse divisions.

Pygidium—Tail.

Cephalic Shield—Head shield—buckler.

Caudal Shield—Tail shield—pygidium.

*Furrows—The longitudinal divisions between the lobes.

Epistoma, Hypostome or Labrum—Names for a \cup shaped mouth piece, found just under the cephalic shield, if *in situ*.

Thorax—Part between the cephalic and caudal shields.

Glabella—The central portion of the cephalic shield, usually separated from the cheeks (lateral portions of cephalic shield) by a furrow or furrows.

Analytical Key.

1. Pygidium united into one piece..... 2
1. Pygidium not so united..... 3
2. Surface of cephalic and caudal shields smooth ..Asaphus.
2. Surface of Shields tuberculated..... 4
3. Pygidium terminating in digitate projections.Ceraurus.
3. Pygidium not dentate..... 5
5. Mesial lobe of pygidium, composed of about 13 segments..... Dalmanites.

* This term is used for other depressions, but generally with an adjective, as neck furrow, etc.

5. Mesial lobe of pygidium, composed of about 6 segments..... *Calymene*.
 4. Cephalic shield, 5-lobed, large, pygidium short. *Lichas*.
 4. Pygidium long; cephalic shield short and small....
 *Palmanites*.

Calymene—(Sig. Concealed.)

1. Evenly granular all over the surface, common; generally coiled; lobes of glabella, three on each side; shell preserved; margin in front of glabella strongly projected and curved upward. *C. senaria*.
 O. I. Conrad.
 Name said to be in allusion to six tubercles on the buckler.

(See Addenda.)

2. Locality, Eaton, O.; Niagara period; all specimens casts of the interior; lobes of glabella, four on each side; attains a larger size than 1. Each segment of the mesial lobe bears a tubercle near the furrow on each side; usually not coiled. *C. niagarensis.*

O. II.

Hall.

Ceraurus—(Sig.—Having the tail horned.)

1. Lateral margins of the glabella parallel; its pairs of lateral lobes nearly equal; pleurae straight and transverse half their length, at which point they bend downward and backward and each bears two small prominences near its inner end; pygidium known by the digitations. *C. icarus.*

Sig.—A mythological name.

Billings.

Q. I.

2. Thorax and pygidium only, have been seen from this vicinity; the first is easily recognized by two rows of small tubercles near the middle of the central lobe, and three rows of larger rounded tubercles on each lateral lobe; the anterior segment of each lateral

lobe of the pygidium is thickened and extended into a long spine; between these spines are five blunt, short spurs. C. pleurexanthemus.

Sig.—A breaking out on the side. Green.

Hall I.

Asaphus—(Sig.—Obscure.) These specimens also bear the generic name Isotelus—(Sig.—Equal ends.)

1. I. gigas. Fragments of all parts of this trilobite are to be found; but few, if any, complete specimens. Flags composed almost entirely of the shields are abundant at Crawford's mills. The hypostome can be identified by many fine parallel feather lines within (on concave surface), and a net-work of lines without. The cephalic shield bears no spines. The eyes are strongly elevated. I. gigas.

Sig.—Large. De Kay.

H. I.

2. I. megistos. Resembles 1; is wider compared with its length; is rare, and is armed with spines at the posterior lateral angles of the cephalic shield.

Sig.—Very large. I. megistos.

O. I. Locke.

Dalmanites.—Proper name.

1. Pygidium only, found here; its mesial lobe is slightly smaller than the lateral lobes and is composed of thirteen distinct segments. D. carleyi.

Sig.—Proper name. Meek.

O. I.

2. Anterior margin of the head slightly produced in front of the glabella; pustules fine; mesial lobe of pygidium containing about 12 segments; cephalic shield short, bearing spines posteriorly. D. breviceps.

Sig.—Short-headed. Hall.

O. II.

Lichas—Sig.—Mythological name.

Glabella narrow behind, arched and expanded in front; buckler apparently five-lobed and pustulated all over; larger and smaller pustules scattered irregularly; on the right and left of the glabella are two large, evenly convex lobes, and to the right and left of these are two smaller lobes. Other parts have not been found here.

L. trentonensis.

Sig.—Proper name.

Conrad.

Hall I.

ADDENDA.

Strophomena alternata var. *loxorhytis*, Meek.

This shell is distinguished from the typical *S. alternata* by from six to eight oblique wrinkles, near the cardinal margin, and toward the lateral extremities.
(See O. I.)

Cyclocystoides —.

The specimens found may be identified by a circle of small quadrate eminences; the specific characters are not yet determined. The specimens are rare.

Lamellibranchs.

There are several of these for which no description is given. They are casts, and as descriptions are generally made from the shell it is a difficult task to identify them; to describe and name them when the same in another form has been named is only to add to the confusion.

Cyrtoceras—(Sig.—Curved horn.)

One specimen in the Earlham College Cabinet is quite perfect on one side, but I can find no description for it, and I did not get it in time to figure and describe it.

Lituites (?)—(Sig.—A trumpet.)

A specimen belonging to Mr. Chandlee is closely related to *L. undatus*, Hall; it has the flattened periphery and general form of that, but lacks the surface

markings. I did not see the specimen in time to figure and describe it.

6. *Pleurotomaria lenticularis* is also known as *Raphistoma lenticularis*.
7. *Calymene senaria* is also known as *Calymene calicephala* (Sig.—A beautiful head). This last seems to me to be the best, as the application of the first is not apparent.
8. *Cypricardites hainesi*.
The cast of this fossil is often found, and is quite different in appearance from the shell itself. The specimen I have is $1\frac{1}{2}$ inches long and $\frac{1}{2}$ of an inch wide; the beaks are not incurved; the large angle between the umbonal ridge and hinge line is preserved. This cast may be readily known by the sharp, hook-shaped upper angle of the muscular elevations.
9. *Cypricardites islandicus*, called also *Cyp. ventricosus*.
10. Most of the specimens here described may be found in the Earlham College Cabinet, the private collection of Mr. Webb, Mrs. Haines' collection, or the High School collection. The places where rare specimens may be found are given under the specific descriptions.

REMARKS

ON THE LIFE DESCRIBED IN THE PRECEDING PAGES.

The highest division of the animal kingdom—the vertebrate—is not represented. The next highest division—the articulate—is only meagerly represented. There are only seven genera and nine species; of these nine species only four are represented by perfect specimens found here. The species, *Conchicolites minor*, (page 51,) is represented by many perfect specimens. All the others are represented by only a few.

The next division in the descending scale—the mollusca—is very largely represented. These are the classes of the Mollusca: Bryozoa, Brachiopoda, Pteropoda, Gasteropoda, Lamellibranchiata, Cephalopoda.

The lowest of these classes—the Bryozoa—is represented by six clearly defined species; of these species, thousands of specimens may be found.

The class next in order—the Brachiopoda—is represented by eight genera and twenty-two species, and the specimens make up most of the flags of which our hills are composed.

The third class—the Pteropoda—is represented by two genera. The genus *Tentaculites*, the simpler of the two in organism, is quite abundant at Crawford's mills, in a stratum higher than the strata near by.

The genus *Conularia* is very meagerly represented anywhere in this vicinity.

The fourth class—the Gasteropoda—is rather abundantly represented by one species—*Pleurotomaria subconica*. The other species and genera may be said to be scarce—quite scarce compared with the Brachiopoda, the lower class.

The fifth class—the Lamellibranchiata—is represented very sparingly, if at all, in the lowest rocks. There are in all six genera; the number of species is undetermined. Eleven of the species are rare, and only four or five species can be said to be at all common, and these are found in the highest rocks of the vicinity.

The sixth class is poorly represented, but its representation follows the usual law: that genus, simplest in its structure—the genus *Orthoceras*—is best represented; and that most complex—the genus *Trochoceras*—is least represented. The shells of the Brachiopoda will outweigh those of all other classes of Mollusca combined.

The next division of the animal kingdom—the Radiata—is also largely represented. There are seventeen well defined species, and all but four are very abundant.

The Crinoids are much less numerous. The same is true of the Cystids. The starfishes—the highest of the

Radiates—are very rare; only three specimens have been found here.

These are some of the facts; many more full of interest are still to be gathered. It was well written by Longfellow, on the fiftieth birthday of Professor Agassiz:

It was fifty years ago
In the pleasant month of May,
In the beautiful Pays de Vaud
A child in its cradle lay.

And Nature, the old nurse, took
The child upon her knee,
Saying: "Here is a story book
Thy Father has written for thee."

"Come, wander with me," she said,
"Into regions yet untrod;
And read what is still unread
In the manuscripts of God."

And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvelous tale.

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